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ABSTRACT

A central theoretical issue is that of the cognitive status of imagery. Detractors emphasize the merely-sensory aspects while proponents emphasize the also-symbolic aspects. Examined with reference to this issue are the theories of Piaget and Bruner, recent studies of concept learning and representation, and studies related to the Craik and Lockhart levels of processing model. (Author)

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SENSORY v.s. SYMBOLIC ASPECTS OF IMAGERY PROCESSES

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Sensory* v.s. Symbolic Aspects of Imagery Processes

Much of the present controversy over the role of visual imagery in cognitive processes centers on the presumed nature of the mental image. Is the image essentially a reconstituted percept, i.e. a high-fidelity representation of concrete objects and events? Or is the image essentially symbolic, i.e., a more flexible and selective representation whose fidelity is to a more abstract idea or concept? In other words, is the image analogous to a color photo of an object or to an abstract drawing of the most essential and meaningful aspects of the object? The distinction markedly influences one's conception of the role and status of imagery in cognitive processes. If the image is primarily a reconstituted percept it is in effect a relatively low level and concrete event which serves mainly to arouse the symbolic (largely verbal) processes which characterize thought and memory. In contrast, if the image is primarily symbolic, it is effectively a higher level concept-like event which serves as a constituent in symbolic processes (along with words) and hence is directly involved in thought and memory.

The issue as I see it is whether imagery is to be considered as merely percept-like or as also symbolic. That it evidences some of the qualities of visual perception is granted, but does it also evidence some of the qualities of a symbol? The research literature provides data and argument favorable to both views.

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*The word "sensory" was chosen for its alliterative appeal when used with "Symbolic." The precise term is "perceptual."

In what follows I will examine the issue briefly relative to theories of development, then consider evidence supportive of a perceptual interpretation followed by other evidence supportive of a symbolic interpretation. Finally, I will explore a basis for reconciling the two perspectives.

With reference to cognitive development, both Bruner and Piaget write disparagingly of imagery, but from different perspectives. For Bruner (1966), imagery is characteristic of that middle stage (Ikonic) of a child's development which is an improvement over the limited Enactive stage which precedes it but which must also be outgrown as the final Symbolic stage is acquired. Imagery (seen as concrete, reproductive and percept-like) is antithetical to symbolic development (seen as abstract and predominantly verbal). A primary accomplishment of cognitive development is the substitution of symbolic for ikonic and enactive thought (Brainerd and Vanden Heuvel, 1974).

Piaget concurs in believing that the imagery of childhood deters (or at least fails to contribute to) higher cognitive development (the development of operations). The errors on certain tasks which are characteristic of the preoperational child are attributable to a certain kind of imagery, i.e. reproductive and static imagery. However, Piaget believes that after concrete operations have been acquired a more flexible and functional kind of imagery develops which is transformational and kinetic i.e. characterized by dynamic change and movement. Thus adult imagery is symbolic and quite functional in thought, problem solving, etc. Both verbal and imaginal symbolic processes serve to represent or refer to or stand for the "content" of thought (Piaget and Inhelder, 1971).

Of these two positions, that of Bruner, which implies a developmental trend from concrete-imaginal to abstract-verbal thought, appears the most widely accepted. Children think concretely, adults think abstractly. I will not attempt here a critical comparison of the perspectives of Bruner and Piaget but will only cite briefly a few recent studies which question or qualify the prevailing Brunerian view.

A study (Miller, 1973) compared the concept choices of first grade children and college freshmen. Stimuli were sets of four objects such that the removal of one object would leave a set of three which would exemplify either a concrete or an abstract concept. Ss were instructed to take away the object that didn't belong, leaving those that were alike. Under these conditions, both children and adults chose abstract concepts over 70% of the time and differed significantly in their concrete or abstract choices for only one of the eight sets of stimuli. These data clearly challenge the view that assigns concrete and abstract thought to children and adults respectively.

Comparisons of memory strategies employed by children in paired-associate tasks have failed to demonstrate a successive developmental pattern in which imaginal processes precede verbal. Though some studies e.g., Jones (1973) suggest that picture-only conditions produce greater learning than word-only for preschool children, other studies, e.g., Dilley and Paivio (1968) and Rohwer (1970), suggest the opposite, and neither indicate differencesof a magnitude to justify conceptualization as successive stages in which either imaginal or verbal processes are markedly predominant. In fact, Jones found that a combination of pictures and words (and presumably a combination of imaginal and verbal processes) was the best overall condition.

Implied is the parallel development of imaginal and verbal processes. Consistent with this is the recent study (Forisha, 1975) in which data from a battery of nine verbal and imaginal measures were compared across grades 1 through 5. Imaginal and verbal processes emerged as independent traits which develop in a curvilinear manner at essentially parallel rates of change.

While, according to these data, children's cognitive processes are not characteristically concrete-imaginal, is it nonetheless the case that adult cognitive processes are characteristically abstract-verbal? There is some counter evidence. For one thing, imagery strategies are typically more effective than verbal in many memory tasks with adult subjects, and in fact it is often difficult, methodologically, to prevent adults in the control condition from spontaneously employing imagery. For another, there is evidence that adult imaginal processes may be operative in higher mental processes such as concept formation. Pertinent evidence will be cited shortly.

On the basis of the discussion thus far it seems necessary to abandon or at least markedly qualify a conception of cognitive developmental stages in which early imaginal processes are replaced by later verbal-symbolic processes. Rather, on the basis of evidence to follow, it will be proposed that development is more accurately characterized as change within types of cognitive representation (verbal and imaginal) rather than between them. Both imaginal and verbal processes develop from relatively limited, concrete, fixed, reproductive phases to more diversified, abstract, dynamic, and generative phases.

Imagery as percept-like

Examined next are several fascinating studies which are consistent with the view that imagery is percept-like. A series of studies by Paivio (1975) employed a size judgment task where the objects were not displayed for direct size comparison and probably had never been seen simultaneously, e.g. a zebra and a table lamp. Ss were presented a pair of names and asked to judge which of the objects referred to was the larger. Response latencies indicated that the greater the actual size difference in a pair of objects the shorter the time required to respond. This is precisely the effect found where size judgments are perceptual, i.e., based on displayed objects. Presumably, Ss employed some imaginal representation of the objects in which size cues were functional. Subjects' post-experimental reports suggest this interpretation as do the data from another study. This time the pairs were pictured, but picture size was held constant within each pair, thus providing no cues for relative size of the objects. Again, response times were inversely proportional to actual object size differences. However, the response times overall were shorter for the pictures than where the object names had been presented, suggesting that the pictures were more consistent with or facilitative of the necessary processes than were the names. This implies an analogous perception-like process such as imagery. If verbal processes had been involved, e.g. word-like lists of object attributes or propositions dealing with size information, then the name condition should have been the more facilitative.

Attention is another percept-like factor that has been found to characterize certain imagery. Kosslyn (1973) presented to Ss ten drawings of oblong objects, some horizontal (boat, snake) and some vertical (man, tower). In each drawing there were details at both ends of the object

and in the middle. Ss were given ten seconds to memorize what each object looked like such that they could generate an accurate visual image of it. In subsequent testing Ss were given five seconds to reinstate an image. Half were to image the whole object and half were to focus "attention" on one prescribed end of the object. Then all were told a detail that might or might not have been part of the drawing. They responded by pressing a yes or no button. For whole-imagers the reaction times did not differ with location of the detail, whether at the ends or the middle. However, for focus-imagers reaction time was a linear function of the distance of the detail from the point of focus. For example, where Ss had been "attending" to the stern of the imaged boat, they responded most rapidly to the nearest detail, the motor, less rapidly to the middle detail, the porthole, and least rapidly to the farthest detail, the anchor. It was as though they were directly perceiving the drawing and had to shift their attention from one part to another.

Such studies strongly suggest that images are simply reconstructed percepts whose main contribution to thought and memory is their veridicality, i.e., their truthful representation of perceptual data rather than their symbolization of the meaning of that data. Conceived in this way, accurate imagery is easily dismissed as too concrete to be of consequence in cognition, and inaccurate imagery is even worse, i.e., proof of the unreliability of such processes. Such criticism tends to overlook the fact that imagery, no matter how percept-like, is a memory process and thus subject to the same loss over time that plagues verbal recall. We simply do not store immutable images forever in a mental picture file.

Imagery as symbol-like

Next to be examined is some of the evidence that imagery can function symbolically. In particular, can imagery be selectively and deliberately generated to serve cognitive purposes? Can imagery be voluntarily manipulated or transformed to solve problems? Affirmative answers come from numerous memory studies (Paivio, 1971). Clearly, people can generate images from words and can even invent interactive relations between the images. The latter is as much an act of cognitive elaboration or transformation as it is of perceptual re-creation.

The elaboration or manipulation of imagery in particular ways for problem solving has been investigated by Shepard and others. In one study (Shepard and Feng, 1972) Ss were shown line drawings of unfolded cubes which they were to mentally fold. Two edges of each cube were marked, and Ss were to indicate whether or not those edges would meet (be adjacent) when the cube was folded together. Reaction times were a linear function of the number of folds necessary to determine adjacency of the two sides. This supported the inference that Ss performed a folding manipulation on their imagery in order to solve the problem. In another study (Cooper and Shepard, 1973) Ss were shown asymmetrical numbers and capital letters in various rotational positions, e.g. 60°, 120°, 180°. They were to judge whether the letters were normal or mirror-image versions. Reaction times were a linear function of the angle of rotation, i.e. it took twice as long to judge a letter that had been rotated 120° as one rotated 60°. Presumably, Ss solved the problem by mentally rotating an image of the letter from its given position back to an upright position so that its normal or mirror-

image status could be determined. Post-experimental reports of Ss further supported this interpretation. Thus, both studies provide evidence supportive of the view that imagery can be purposefully modified from the given perceptual data such that spatial problems can be readily and reliably solved.

Salomon (1974) has explored the possibility that such imaginal processes could be taught, and that skill developed with them might transfer to other situations, functioning as a general cognitive skill or strategy. Two cognitive operations involving visualization were investigated: (1) examining details of objects and (2) laying out of solid objects (essentially the reverse of Shepard's above task of folding together a cube). Both operations were modeled for Ss by means of films. For example, one film repeatedly zoomed in on various details of a painting, thus modeling a cognitive process which the Ss presumably would learn to imitate covertly through imagery. Another film showed the sides of a solid object being gradually layed out, one at a time, until a flat view was revealed. Then the sides were shown folding back together into a solid object. The repeated presentation of this process presumably taught the imaginal process. As anticipated, experimental Ss performed transfer tasks significantly better than did control subjects. Those who presumably internalized the zoom in on detail were superior on a cue attendance test, and those who presumably internalized the laying out of solid objects were superior on a visualization test. Thus, certain forms of filmic visualization can apparently be learned and employed as generalized cognitive schema or imaginal strategies for solving new problems.

The imagery probably implicated in such tasks as zooming in, unfolding, and rotating is certainly not static or reproductive. It is instead kinetic

and transformational. Such imagery fits Piaget's conception of adult imagery (symbolic) much better than it does Bruner's conception (object-bound, percept-like).

The relation of imagery to verbal learning goes beyond that of it's well-known use as a mnemonic device for memorizing pairs or lists of unrelated words. Recent research on meaningful prose suggests that imagery may aid understanding as well. In several studies e.g. Levin, Bender, Lesgold, 1976, first grade children listened to orally presented stories and at the same time saw pictures of the described events. Subsequent verbal recall of information about the stories (short answer questions) was significantly greater for Ss seeing the pictures while listening to the words than for those listening to the words once or even twice. More direct evidence of the effect of imagery on understanding words has come from studies in which imagery instructions have been employed instead of pictures. However, there is some evidence that imagery and reading processes can interfere with each other, presumably because they both involve the visual modality. Accordingly, in a subsequent study (Pressley, 1976) third grade Ss read printed stories, but were instructed to stop after each paragraph and form a picture in their heads of what they had just read. This procedure facilitated information learning as compared to a control group without imagery instructions. Apparently this alternate processing of visual words and visual imagery avoided overloading the visual system. What is important here is that such studies suggest important interactive effects between imaginal and verbal processes, effects that merit further investigation.

There is also initial evidence (Denburg, 1977) that especially designed pictures can facilitate some aspects of learning to read. Despite much evidence to the contrary (Samuels, 1970), certain beginning readers were shown

to benefit from the additional information available in pictures showing the actor noun, the object noun, or both. Such information had a large facilitating effect on word identification in sentence contexts and a smaller, but significant, effect on word learning. The extent of imaginal process involvement in these effects is only speculation at this point. However, it seems quite plausible that nouns can be learned and made meaningful by association with images of the objects named. Again, much more research is needed.

Imagery and Concept Formation

What evidence is there that imagery influences concept learning? Recall Bruner's position, noted earlier, that ikonic imagery is a deterrent to the child's development of symbolic processes. The idea is that imagery processes (considered as percept-like) deal with the more apparent, though superficial, concrete aspects of objects and events and thus delay or compete with the development of symbolic processes (verbal, abstract, conceptual, propositional). The study frequently cited in support of this view is that by Kuhlman (Hollenberg, 1970). Children of grades 1-4 were pretested for imagery ability by means of spatial perception and manipulation tests. They were then given an object labeling task and a concept identification task. Kuhlman found that Ss with high-imagery skills learned nonsense labels for objects more rapidly, but formal concepts less rapidly, than low-imagery Ss. The implication widely drawn has been that high-imagery children as a group are thereby disadvantaged in concept learning. However, Kuhlman's data show that by grade four the effect is absent, i.e., high-imagery fourth graders formed concepts as readily as matched (sex, IQ, grade level) low-imagery Ss. Kuhlman interprets this as follows: ". . .high-imagery chil-

dren had developed some strategies that enabled them to compensate for the deficiencies in concept attainment seen in the younger high-imagery children." (p. 1012) However, the change by fourth grade can no more be attributed to some unknown compensation for imagery than to a gradual perfection or diversification of imagery, especially of abstract imagery. I believe a developmental interpretation is the more appropriate, i.e., the high-imagery Ss in grades 1-3 had not yet learned to use their skill selectively. They may have clung longer than desirable to a memory strategy involving rich imagery, which was highly functional for associating names with objects, but which interfered with selection of the criterial attributes of concepts. However, by 4th grade they had developed additionally a more selective and abstract perceptual and imaginal strategy which at least did not interfere with concept identification and might even have facilitated it.

This proposed reinterpretation of the Kuhlman data has not as yet been investigated systematically. However, several more-recent studies further illuminate, but don't settle, the issue of the percept-like vs. symbol-like status of imagery. Katz and Paivio (1975) examined some imagery variables in a standard concept identification task. A pilot study group of Ss reliably rated the imagery value of 27 category names, and the three highest and three lowest names were selected for the experiment. For example, one of the category names was "a type of vehicle," and the instances or examples used to teach it were like the following: bicycle, truck, motorcycle. Half the Ss were given instructions to image each instance and half were not. As expected, the results showed that concepts with high imagery names were learned at a significantly higher rate than those with low ima-

gery names. Further, Ss given imagery instructions made fewer errors than the others. These data strongly implicate imagery processes in a concept identification task and thus call into question Kuhlman's assumption that imagery strategies would deter concept learning.

One of the long standing issues in concept learning theory is whether a concept is cognitively represented as a word or proposition, as a generic abstraction, or as a prototypic concrete instance. In other words is one's concept of "flower" cognitively represented as a list of attributes (word-like), or as some abstract essence of all flowers (generic image), or as a common and typical instance such as a rose (specific image)?

The logical possibility of a generic image has long been argued e.g. Locke vs. Berkeley, and has centered around concepts such as triangle and animal. Is it possible to construct a generic image of triangle that "represents" all shapes and sizes of triangles, or of animal that "represents" all forms of animals? Brown (1958) argues persuasively the negative position and Arnheim (1969) the affirmative.

The issue resides, I feel, in the meaning of "represent". Clearly, one concrete image cannot depict with fidelity all shapes of triangles. But one abstract image can selectively accentuate the criterial attributes, e.g. three angles, which characterize all triangles and hence in this sense can "represent" the concept triangle.

That we readily form visual abstractions (essentially spatial concepts) has been demonstrated (Posner, 1973) in studies requiring Ss to learn to categorize such nonverbal stimuli as geometric figures and faces. From numbers of examples of such nonverbal stimuli Ss apparently develop a mental

prototype (generic image) by which never-seen-before examples can readily be identified. Further, Ss can often identify examples accurately well before they can verbally describe what attributes they are employing.

Some recent work by Rosch (1975) suggests the view that concrete concepts are cognitively represented (at least initially) as prototypic examples or instances. Subjects were asked to judge the representativeness of certain instances e.g., chair and table for concepts e.g. furniture. Ratings of instance representativeness (scale of 1-7) were highly reliable (split-half correlations of .97 or higher) instead of idiosyncratic. For example, "pants" and "shirt" were judged by most Ss to be more representative of the concept "clothing" than were "gloves" or "purse", though all these instances conform to the verbal definition and to the list of defining attributes. Thus, there were certain concrete examples (probably represented cognitively by images) which were of psychological significance as "good" or prototypic examples, and which in a sense stood for or "represented" the concept.

In a quite different study (Anderson and McGaw, 1973) the evidence suggested a similar conclusion. In an associative learning task, stimuli (embedded in sentences) were concept names, e.g. animal, and recall cues were instances of the concept, e.g. dog, wolf, squirrel. On the assumption that "animal" is likely to be cognitively represented by an image of an instance such as "dog," it was predicted that "dog" would cue the most recall, "wolf" (animal like a dog) would cue less recall, and "squirrel" (animal unlike a dog) would cue least recall. The data supported this prediction. Recall varied directly with the similarity of the cue to the prototypic or "good" example of the concept. Implied again is the cognitive representation of concepts as images of "good" examples rather than, or in addition to, lists of abstract features.

It thus appears that a common argument for denying imagery any conceptual status, i.e., one cannot image the abstract essence of "fruit," may be irrelevant where the cognitive representation of "fruit" is found to include a readily imageable "good" instance such as an apple.

One of the presumed characteristics of imagery, other than its relative concreteness, which is frequently used to question its symbolic status is its idiosyncracy. In contrast to verbal thought, which is constantly externalized in speech and writing and thus subject to testing and shaping (by parents, peers, teachers, society), imagery is not typically externalized (e.g., drawings, photos) and thus represents only private and idiosyncratic (consequently unreliable) observations and meanings. At this time of renewed scholarly interest in the internal life of the individual and of renewed educational interest in individual differences and individualized instruction, I will not argue the importance of understanding the unique individual. Rather, I will argue for some equalization of the private or public status of verbal and imaginal processes.

First, it's apparent that large amounts of both verbal and imaginal processes proceed without anyone's awareness; they are unconscious or only fleetingly conscious.

Second, the public and verified character of language is more apparent than real. Though we employ many of the same words and subscribe to the same dictionary definitions, our meanings are inevitably relative--relative to the particular context of use (see Bransford and Johnson, 1973) and to our individual history of experiences and associations. Contrariwise, technical language can approximate precision within the respective academic and professional communities.

Third, new media, e.g., TV, film, magazine are giving a public character to the people and events shown and thus to hitherto private imagery. When our imagery was limited to the people and events within walking distance it tended to be locale-specific and only words permitted some larger perspective. But now, many persons, objects, events are experienced in common throughout a culture and between cultures, and are experienced through both picture and word media. Thus, differentially idiosyncratic imagery more nearly evidences differences in the opportunity for common experiences (and hence common internal representations) than differences in the nature of representation.

Fourth, a good deal of shared language experiences are referenced to imagery. For example, a person describing his vacation will likely be imaging places and describing those images. Reciprocally, the listener in trying to understand and appreciate the description may generate "matching" images. Such dialogue effects some equalization of word and image meanings across participants. In fact, the degree to which conversing parties can and do compare by speech their separately held images is predictive of the mutuality of meaning they will achieve. Also, the likelihood that the vacationer will share some color slides further assures the socialization of numerous images.

It is abundantly clear from research to date (e.g., Paivio, 1971) that people can translate imagery to words and words to images, and appear to do so readily. Thus, for the above reasons, the simple dichotomy: words are public and images are private, is an oversimplification if not a distortion.

To the extent that the foregoing has established the symbolic character of imagery, a dilemma arises: How can one process be both concrete percept-like and abstract symbol-like. One approach to the problem is to shift the discussion from internal representation (imaginal and verbal) of information to the presumably analogous external representations or signs (pictures and words, e.g. print and speech). Words, without question, represent both concrete and abstract referents. One word refers to a concrete object and another to an abstract idea. The distinction is an arbitrary one; certain concrete meanings become associated with one word and certain abstract meanings become associated with the other. Pictures can also represent both concrete and abstract referents. However, the distinction is non-arbitrary in that the concrete or abstract qualities of representation are directly observable, for example in a color photo of an object as compared to a painting or outline drawing. Both the word MAN and a stick figure of a man refer to the concept man. They are both symbolic representations, i.e., they refer to some common meaning but are not themselves that meaning. In this sense, the analogous cognitive representations (imaginal and verbal) are both symbolic. Whether representing concrete or abstract information they both function as symbols in that they stand for what they refer to. The idea is implicit in the term "code", which is used for information in neural form regardless of the content of the information.

A second approach to the problem of reconciling the percept-like and symbol-like characteristics of imagery is to propose a continuum of imagery from the more concrete to the more abstract. This range of imagery would be generated from a comparable range of remembered information. Apparently compatible with this conception is the levels-of-processing model of Craik

and Lockhart (1972). According to the model, a hypothetical series of perceptual analysis and processing levels extends from the sensory to the semantic level. Importantly, memory is conceived as a continuum as well, "from the transient products of sensory analyses to the highly durable products of semantic-associative operations." This model appears to accommodate both the percept-like and symbol-like poles of the proposed imagery continuum. Further, though sensory information is properly considered the most transitory, the possibility of recycling, by way of imagery rehearsal, at relatively concrete levels accommodates evidence (Horowitz, 1972) that vivid imagery may occasionally be retained for longer periods.

The above levels-of-processing model is analogous to Hebb's (1968) physiological model of imagery. He hypothesizes several levels of neural cell assemblies in which the first order neural cell-assemblies are related to specific vivid imagery while second and third-order cell-assemblies are related to more general imagery and to conceptual processes.

Although most of the research evidence to date deals with levels of verbal processing, evidence for levels of processing within both verbal and imaginal systems comes from a series of studies by Friedman and Bourne (1976). They employed a speeded-inference task which permitted some separation of physical information processing from conceptual information processing for both word and picture stimulu. Subjects were to infer concepts e.g. animal and vehicle, from pairs of examples. The data indicate that for physical information processing, that for pictures generally occurred more rapidly than that for words. The data for the conceptual level of information processing revealed no difference in processing time between words and pic-

tures. These data suggest that pictorial information need not be recoded into verbal form but instead can directly access semantic levels of processing.*

Particularly pertinent for the present discussion was the observation of a levels-of-processing effect (indexed by reaction time) which was a function of type of task. Responses relevant to physical properties of the stimuli tended to occur more rapidly than did responses related to conceptual properties, and this levels-of-processing effect occurred regardless of whether stimuli were in word or picture form.

However, it does not necessarily follow from these data whether the observed levels of information processing involved either verbal or imaginal codes or both. Though the word and picture stimuli might be expected to differentially favor verbal and imaginal symbolic processes, the functional interchangeability of the two leaves the involvement of either an open question.

This paper has provided evidence to support the symbolic status of imagery. It has also considered evidence for a levels-of-processing and levels-of-memory model in which imaginal symbolic processes are placed on a continuum from percept-like to symbol-like levels, thus accommodating the research findings that imagery can evidence both perceptual and symbolic characteristics.

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*This finding is consistent with a revised model (Craik and Tulving, 1975) in which a strict sequential series of processing levels is modified to accomodate evidence, such as above, that naming levels may be skipped over.

What is needed in my view is further research evidence to clarify and extend our understanding of the presumed higher levels of imaginal symbolic processes. What is also desirable, for investigators of cognitive processes generally, is greater awareness of the possible involvement of imaginal processes in their obtained effects and thus more use of procedures to control or manipulate or measure such variables along with the others of interest.

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